Fall 11-26-2013

Sex Differences in Mother-Infant Interaction

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by

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A thesis submitted in partial fulfillment of the requirements for the degree of

Master of Science in Experimental Psychology

with a concentration in Behavioral Neuroscience

Department of Psychology

Seton Hall University

November, 2013

Dedication

This thesis is dedicated to my grandfather, who taught me that love and goodness always prevail.

Acknowledgements

I would like to thank all of the members of my committee, Dr. Joh, Dr. Goedert, and Dr. Lewis for guiding me throughout this process. I can't express how grateful I am for their time and dedication. They have taught me that by working together great things can be accomplished. I would also like to extend a sincere thank you to everyone at the Institute for the Study of Child Development for all of their help along the way. Without their support none of this would have been possible.

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Abstract

Sex differences in human behavior have frequently been explored by researchers. Although there are numerous studies documenting sex differences between boys and girls from childhood into adulthood, few studies have adequately examined how genetics and environment interact in infancy to promote sex differences in infant behavior. Therefore, the present study sought to examine how sex differences in maternal behavior interact with differences in infant behavior. Maternal and infant behaviors were analyzed within the still-face paradigm, a paradigm which allows for examination of mother-infant interaction in normal, stressful, and recovery situations. It was hypothesized that infant boys would react with more negativity than girls to the stressful phases of the paradigm. It was also hypothesized that mothers would continuously treat their girl infants with more positivity, and maternal behavior would not be consistent across the phases of the still-face paradigm, ultimately becoming more negative by the end of the procedure. It was expected that these sex differences in maternal behavior, coupled with maternal increases in negativity, would translate to greater negativity in boys versus girls by the end of the procedure. Infant and maternal behavior was videotaped within the still-face paradigm and behaviors and facial expressions were later coded. All of the hypotheses were supported. Infant behavior differed by sex, with boys demonstrating more negative emotionality than girls in the recovery phase. Furthermore, mothers of girls treated their infants with more positivity than mothers of boys throughout the entire procedure. Maternal behavior also became more negative by the end of the procedure, which likely contributed to increased negativity seen in boys but not girls by the end of the procedure.

Introduction

Over the past century, sex-related differences in socio-emotional behavior have been a subject of interest to researchers and educators. Sex differences in emotional expression and regulation have been noted across the lifespan, from childhood into adulthood. Throughout childhood and adolescence girls show more positive and internalizing emotions such as anxiety or sadness, whereas boys show more externalizing emotions, most prominently anger (Chaplin & Aldao, 2013). Specifically, boys express more anger than girls in competitive games and show more expressions of negativity than girls when given a disappointing gift, whereas girls suppress more anger than boys and smile more often than boys (Hubbard, 2001; Davis, 1995; Cox, Stabb, & Hulgus, 2000; Dodd, Russell, & Jenkins, 1999). Beginning in adolescence, girls are also more likely to experience clinical depression than boys (Hankin et al., 1998).

These sex differences between externalization and internalization of emotion in children extend into adulthood (Chaplin & Aldao, 2013). As adults, men are more likely to be diagnosed with mental illnesses associated with externalizing emotions such as antisocial personality or substance abuse disorders, whereas women are more likely to be diagnosed with mental illnesses associated with internalizing emotions such as mood and anxiety disorders (Eaton et al., 2012; Kessler et al., 1993). Adult men react to anger-invoking situations with more physical and verbal anger than women, while women respond with less hostility and more submission (Biaggio, 1989). Women also have significantly more fearful reactions when presented with negative stimuli; they self-report feeling more intense emotions than men, cry more often than men, and have been found to smile more often than men (Bradley, Codispoti, Sabatinelli, & Lang, 2001; Grossman & Wood, 1993; Walter, 2006; Dodd, Russell, & Jenkins, 1999).

These life-long sex differences are likely due to a complex interplay between social, cultural, and genetic factors. However, delineating the contributions of environmental and genetic factors in the development of child and adult sex differences is difficult, since gender socialization increases as children are exposed to more social situations outside of their home environments (Fagot, Hagan, Leinbach, & Kronsberg, 1985; Chen & Rao, 2011). One way of addressing this problem is to examine sex differences in infancy, prior to extensive socialization by individuals other than primary caregivers. The current study examined the influence of environmental effects on 2.5-month-old infants, specifically on how maternal behavior varied with the sex of the infant and how such variations in maternal behavior affected infants' own behaviors. Studying sex differences early in infancy provides a better understanding of how caregiver behavior can potentially influence later differences seen in boys' and girls' emotional expression and regulation.

The Study of Sex Differences in Infant Behavior

In order to understand infant socio-emotional development researchers have examined how infants act within a variety of contexts, including free play situations and during brief separation from mothers (Goldberg & Lewis, 1969; Ainsworth & Bell, 1970). One way in which researchers have repeatedly studied young infants' interactions with their parents is by using the still-face paradigm. In the still-face paradigm, infants are exposed to a sudden interruption of social interaction and their responses (facial expressions, eye gaze) are recorded. Mothers are instructed to interact with their infants through facial expressions and talking (phase 1 or play period), stop interacting by maintaining an inexpressive face (phase 2 or still-face phase), and again interact with infants in play (phase 3 or reunion phase). This paradigm is one of the most widely used in the study of infant socio-emotional behavior, as responses to the procedures of the still-face have been linked to later attachment, self-regulation, and differences in emotional externalization/internalization (Fuertes, Lopes dos Santos, Beeghly, & Tronick, 2006; Hill &

Braungart-Rieker, 2002; Moore, Cohn, & Campbell, 2001). Specifically, researchers have found that an absence of infant crying during the still-face portion of the paradigm at 6 months is linked to decreased internalization at 18 months, whereas an absence of smiling is related to increased externalization at 18 months of age (Moore, Cohn, & Campbell, 2001). Such associations have made the paradigm critical in the study of sex differences in infant socio-emotional functioning.

The still-face paradigm was created to reveal how infants interact with their mothers in non-stressful (phase 1) and stressful (phase 2) contexts, as well as how they recover from a stressful situation (phase 3). In a seminal study, Tronick and colleagues (1975) noted that infants show “still-face effects,” becoming cautious and withdrawn and looking away from their mothers during the still-face phase of this paradigm. Further studies with infants between 6 weeks and 6 months reported increased negative affect, decreased direct gaze, and decreased smiling during the still-face phase (Tronick, Ricks, & Cohn, 1982; Murray & Trevarthen, 1985; Gusella, Muir, & Tronick, 1988; Striano & Bertin, 2004). Such increases in negative emotionality during the still-face phase have been assumed to indicate that maternal cessation of interaction is stressful for infants, and when mothers do not help infants regulate their emotions, infants use their own regulatory capacities (Carter, Mayes, & Pajer, 1990). The stressful nature of the still-face phase is confirmed by studies revealing increased heart-rate during the still-face phase, as well as an increase in the secretion of the stress hormone cortisol (Ham & Tronick, 2006; Haley & Stransbury, 2003).

Also, despite maternal efforts at reengagement, infants show “carry-over effects” from phase 2 to phase 3, behaving hesitantly (engaging in “wary monitoring”) and maintaining negative emotions once mothers are instructed to begin normal interaction (Bendersky & Lewis, 1998; Tronick, Als, Adamson, Wise, & Brazelton, 1978; Weinberg & Tronick, 1996). The presence of these carry-over effects has been interpreted as an indication that infants do not easily recover from a break in normal interaction with mothers, with prolonged stress (still-face) having lasting consequences (Weinberg, Beeghly, Olson, & Tronick, 2008).

When analyzing sex differences within the still-face paradigm, researchers have repeatedly focused on how infants react to the still-face phase. However, studies have revealed inconsistencies in outcomes related to sex differences. For example, some studies reveal that infant girls display more distress when mothers cease interaction, as evidenced by increases in crying (Stoller & Field, 1982; Mayes and Carter, 1990; Braungart-Rieker, Garwood, Powers, & Notaro, 1998). In contrast, other studies reveal that during the still-face phase infant girls display temporary positive behavior more frequently than boys and girls gaze more at their mothers during the still-face phase than boys (Cohn & Tronick, 1983; Egami et al., 2008; Weinberg, Tronick, Cohn, & Olson, 1999). Finally, some researchers have failed to find any notable sex differences between boys and girls (Toda & Fogel, 1993; Cossette, Pomerleau, Malcuit, & Kaczorowski, 1996; Abelkop & Frick, 2003).

Researchers have attempted to explain these inconsistencies in findings by emphasizing inconsistencies in the ages of infants tested, methodologies used, as well as different variants of the procedure used to conduct the still-face experiments. Infants have ranged from 2 ½ months to 6 months of age; methodologies have varied from analyzing the phases separately to computing difference scores between phases; and variations in procedures have consisted of phases lasting between 1 to 3 minutes (Cossette et al., 1996; Weinberg, Tronick, Cohn, & Olson, 1999; Moore et al., 2009; Haley & Stransbury, 2003; Forbes, Cohn, Allen, and Lewinsohn, 2004). Yet, it is unlikely that these explanations alone suffice to explain the instability in findings on gender differences in infancy, as studies using like methodologies, procedures, and testing infants of the same age have produced divergent findings (Weinberg, Tronick, Cohn, & Olson, 1999; Abelkop & Frick, 2003).

Gaps in Previous Research

What researchers have largely failed to examine in studies of sex differences within the still-face paradigm are sex differences in infants within the reunion phase and more strikingly, sex differences in maternal behavior across all phases of the still-face paradigm. Analyzing infant behavior solely in phases 1 and 2 of the still-face paradigm provides an incomplete picture of sex differences between boys and girls. Furthermore, failing to analyze sex differences in mothers in tandem with sex differences in infants precludes the possibility that socialization is a contributor to observed differences in emotional expressivity between boy and girl infants. It could be the case that there are differences in maternal behavior in phases 1 and 3 contributing to observed sex differences.

Analysis of the reunion phase. The reunion phase is critical in the examination of sex differences in affective processing because it reveals how infants reengage once mothers resume interaction. Specifically, findings from the reunion phase reveal how infants recover from the stressful still-face phase. Notable sex differences within the reunion phase may help to explain later differences found between boys and girls in the development of externalizing versus internalizing emotions. Yet, despite the importance of the reunion phase some researchers have failed to analyze the reunion phase or removed it from their still-face procedures altogether (Hart, Carrington, Tronick, & Carroll, 2004; Braungart-Rieker, Garwood, Powers, & Notaro, 1998; Cossette, Pomerleau, Malcuit, and Kaczorowski, 1996). If any conclusions about sex differences in infant behavior are to be drawn, inclusion of the reunion phase is necessary.

Analysis of maternal behavior. Most of the inconsistencies in sex differences in infant behavior could be better explained if sex differences in maternal behavior within the still-face paradigm were simultaneously analyzed with infant behavior. Researchers studying sex differences in infants within the still-face paradigm have specifically failed to evaluate 1) sex differences in maternal behavior 2) differences in maternal interactive style or 3) changes in maternal behavior across phases 1 and 3 of the still-face paradigm (Weinberg & Tronick, 1996; Weinberg et al., 1999; Cossette et al., 1996). In-depth analysis of maternal behavior is critical, as close inspection of previous studies suggests that maternal behavior is largely inconsistent.

Sex differences in maternal behavior. Studies that have examined maternal behavior reveal differences in how mothers treat boy and girl infants**.** Moss (1967) observed natural interactions in a home setting between 3-week-old infants and their mothers and found that mothers held their sons upright longer than their daughters. Conversely, they vocalized more to their daughters and responded more to their emotional states. Consistent with Moss, Lewis (1972) found that mothers of 3-month-old boys touched, held, and rocked their infants more than those of girls. However, mothers vocalized to and looked at their girls more than their boys. Golombok and Fivush (1994) later speculated that such differences in maternal touch could be due to efforts on mothers' parts to calm boys.

Furthermore, these sex differences in maternal behavior continue as infants mature. Goldberg and Lewis (1969) found that by the time children were 6 months old, mothers of girls touched, vocalized to, and breast-fed their infants more frequently than mothers of boys. Similarly, Clearfield and Nelson (2006) found that when observed in a free play interaction, mothers consistently interacted more with girls than with boys at 6, 9, and 14 months of age. Overall, mothers appear to interact more with their girl infants versus boy infants, although sex differences in touch appear to be modulated by sex differences in infant behavior at earlier ages. Given these apparent differences in maternal behavior outside of the still-face paradigm, it is reasonable to speculate that mothers may treat boy versus girl infants differently in the still-face paradigm. Specifically, mothers may interact more with girl versus boy infants with increased touching, vocalizing, and looking at girls. Yet, with boys that exhibit marked negative emotionality, mothers may be more likely to touch and hold boys than girls.

Differences in maternal interactive style. The aforementioned differences are important, because differences in mothers' behaviors in the still-face and reunion phases of the still-face paradigm are associated with differences in infant behavior. This is revealed by studies which show a relationship between maternal behavior in phase 1 and infant behavior in phase 2, with increased maternal responsiveness in phase 1 being associated with decreased infant negativity in phase 2 (Tronick, Ricks, & Cohn, 1982; Lowe, Handmaker, & Aragón, 2006). This influence of maternal behavior continues into the reunion phase of the paradigm, with increased maternal sensitivity in phase 1 being associated with decreased infant negativity in phase 3 (Kogan & Carter, 1996). Such differences in maternal behavior make it difficult to draw conclusions about the etiology of infants' emotional reactions to the still-face and reunion phases. Infant behavior within the phases of the still-face paradigm could be a response to individual differences in maternal interactive behavior.

Changes in maternal behavior. The still-face paradigm assumes that maternal behavior is consistent between phases 1 and 3. It is easy to accept this as a fact, as mothers are instructed to behave upon reunion as they did within phase 1. However, previous studies reveal that this is not the case. In a study examining infant and maternal behavior within the still-face paradigm, Weinberg, Olson, Beeghly, and Tronick (2006) found significant increases in maternal negativity and decreases in positivity between phases 1 and 3. The authors interpreted this finding as an indication that mothers struggled with controlling infants' increased negative affect in the reunion phase (Weinberg et al., 2006).

However, despite Weinberg, Olson, Beeghly, and Tronick's (2006) interpretation of the findings, infants' maintenance of negative emotionality between phases 2 and 3 could be a function of mothers' increase in negative emotionality between phases 1 and 3. Mayes, Carter, Egger, and Pajer (1991) briefly discussed this possibility by arguing that some mothers never return to phase 1 levels of positive emotionality, as they themselves are left feeling uneasy by the still-face situation. In their study more than half of mothers reported feeling uncomfortable during the still-face situation and those who felt uncomfortable were more likely to hold their infants and talk about their negative feelings about phase 2 in the reunion phase (Mayes, Carter, Egger, & Pajer, 1991). Additionally, studies have found a relationship between maternal behavior within the reunion phase and infant responses during the reunion phase, with more positive maternal emotionality being associated with a decrease in infant negative affect (Rosenblum, McDonough, Muzik, Miller, & Sameroff, 2002; Spitzer, 2000). Given these findings, it is likely that increases in maternal negative emotionality in phase 3 exacerbate, if not cause, infant negative emotionality in phase 3.

Overall, a plethora of relationships exist between mothers and their infants. As shown in Figure 1, it may be the case that maternal behavior between phases differs according to the sex of the child, which may affect the infant's behavior between phases. Specifically, maternal behavior during phase 3 of the paradigm may differ according to the sex of the child, which may in turn affect the infant's reunion behavior. Mothers' influence on their infants as a function of infants' gender can be examined both within each phase as well as across phases. Mother's behavior in phase 1 can be examined as it relates to the infant's behavior in phase 1. It can also be examined in terms of infant behavior in phase 2 and phase 3. Likewise maternal behavior in phase 1 can be compared to her behavior in phase 3 as it affects the infant's behavior in phase 3. Moreover infant's behavior in phase 2 can be related to maternal behavior in phase 3 as well as infant behavior in phase 3, all a function of the sex of the child. These relationships between mothers and infants have not been adequately assessed by researchers.

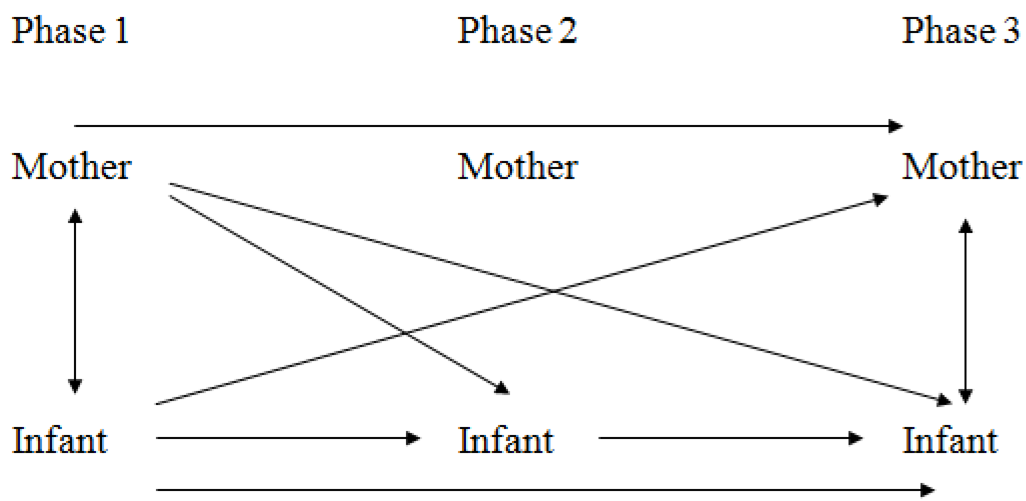

Figure 1. An illustration of possible relationships between mothers and their infants within the still-face paradigm. Two-sided arrows reveal a two-way relationship, whereas one-sided arrows reveal a one-way relationship.

Current Study

The current study examined sex differences in mother-infant interaction in the still-face paradigm. To date, no studies have extensively examined sex differences within all phases of the still-face paradigm in infants as young as 2.5 months old and their mothers. Previous researchers examined sex differences in 2.5 month infants within the still-face paradigm but they failed to examine sex differences during the reunion phase and their analyses of maternal behavior were rudimentary, as revealed by Cossette et al. (1996). Interestingly Cossette et al. (1996) mentioned that sex differences in infant behavior should be analyzed in a wide variety of contexts, but the reunion phase was never incorporated into their study. Based on the literature on sex differences in mother and infant behavior and maternal behavior within the still-face paradigm, several hypotheses were advanced.

It was hypothesized first that gender differences in infants' socio-emotional behavior would be present within the still-face phase and reunion phase. Based on discrepancies in outcomes related to sex differences in previous studies utilizing the still-face paradigm (Stoller & Field, 1982; Cohn & Tronick, 1983; Abelkop & Frick, 2003), the direction of the gender differences could not be predicted. However, based on the reported findings on sex differences in childhood and adulthood (Chaplin & Aldao, 2013; Biaggio, 1989; Eaton et al., 2012), it was expected that boys would react with more externalizing emotions, specifically negative vocalizations and negative facial expressions, to the still-face and reunion phases than girls. Secondly, it was hypothesized that mothers would exhibit different behaviors towards boy and girl infants, with mothers of girls gazing, touching, vocalizing, and smiling more at their infants. Such differences have been observed outside of the still-face paradigm in maternal interactions with infants (Goldberg & Lewis, 1969; Clearfield and Nelson, 2006). Third, it was hypothesized that mothers would display an increase in negativity between phases 1 and 3. This increase in negativity was predicted based on increases in maternal negativity reported in previous studies (Weinberg et al., 2006; Mayes et al., 1991). Finally, given the hypotheses about sex differences in infant reunion behavior, sex differences in maternal behavior, and increases in maternal negativity between phases 1 and 3, it was hypothesized that boys would experience a greater continuation of negativity from phase 2 to phase 3 than girls. Boys would react with a continuation of negativity due to mothers' already decreased stimulatory behaviors towards them and maternal increased negativity by phase 3.

Methods

Participants

One hundred and thirty-three 2.5-month-old infants (61 girls and 72 boys) and their mothers participated in this study. Infants ranged in age from 8.5 to 13 weeks (*M* age = 11.30 weeks, *SD* = 1.06). An additional 17 infants were tested, but they were excluded from the final sample due to being born pre-term or excessive crying during the reunion phase of the still-face paradigm. Infants' mothers ranged in age from 22 to 44 years (*M* age = 32.44 years, *SD* = 4.85) and a majority of mothers (60%) held middle-class jobs. Analyses (*t* tests) indicated no significant demographic differences between mothers of boys versus mothers of girls.

Participants were recruited from affiliated medical centers in New Brunswick, NJ. Mothers and their infants were representative of the demographics of births in the area. They were mostly of White/European ancestry (59% of infants). Other ethnicities included African American (8%), Hispanic (14%), Asian (3%), Indian-Subcontinent (5%), and Non-Hispanic Mixed/Biracial (11%).

All infants were healthy without diagnosed disorders related to sight, hearing, or development. The only exception was one infant who suffered from laryngomalacia, or congenital softening of the tissues of the larynx. Since this condition did not affect the infant's cognitive or social abilities, he was included in the final sample. All infants were born at term (81% of infants) or post-term (19%).

Procedure

Mothers and infants were videotaped in Tronick's still-face paradigm in a home setting (Tronick, Adamson, Als, & Brazelton, 1975). Infants were placed in an infant seat and mothers sat in front of them, facing their infants. One video camera was used to record a side view of mothers' and infants' facial expressions during the 8-minute session.

During phase 1, mothers interacted freely with their infants. Mothers were told to behave as they typically would with infants, ignoring the presence of an observer. Phase 1 generally consisted of mothers speaking to their children, playing with them, and interacting with them. Phase 1 lasted 3 minutes. During phase 2 (still-face phase), mothers ceased interacting with their children by dropping their heads. Mothers were instructed to not speak to or touch their infants during this interruption. Phase 2 lasted 2 minutes. Finally, during phase 3 (reunion phase), mothers again interacted freely with infants. Mothers were once again instructed to play as they typically would with children. They were allowed to touch, vocalize, and look at their children. Phase 3 lasted 3 minutes. The entire procedure lasted 8 minutes.

Coding

To examine changes in infants' and mothers' behaviors, videotapes were coded using the Maximally Discriminative Facial Movement Coding System – MAX (Bennett, Bendersky, & Lewis, 2002).

Infant behaviors. Infant gaze states, vocalizations, touch, and facial expressions were coded second by second during the entire 8 minutes. The expressions scored were full and upper face expressions and coding was done with the volume off in slow motion. Volume was only turned on to code vocalizations. Table 1 presents a summary description of the behaviors and facial expressions which were coded. Due to a lack of prevalence of mother-infant diverted gaze, interest, infant touch, and sleepiness, these behaviors and facial expressions were not included in the final analyses.

Table 1.

Definitions of Infant Codes for Behaviors and Facial Expressions

Dimension	Definition
Gaze	Gaze A: Mutual gaze – mom looking at infant, infant looking at mom Gaze B: Mom looking at infant/Infant looking away Gaze C: Mom looking away/ Infant looking at mom Gaze D: Both mom and infant looking away
Vocalizations	Positive Vocalizations: Infant vocalizations that are not clearly negative Negative Vocalizations: Negatively toned infant vocalizations. Includes fussing, grunts, crying Neutral Vocalizations: Infant vocalizations such as burps, sneezes, coughs, hiccups
Touch	Infant reaches out to touch mother
MAX Facial Expressions	Enjoyment (smile, upper/lower face) – MAX code = 52/33-52 Interest (any of several, upper/lower) – MAX code = any Anger (upper/lower) – MAX code = 25/55-54 Sadness (upper/lower) – MAX code = 23/56 Anger/Sad (anger upper/sad lower) – MAX code = 25/56 Sad/Anger (sad upper/anger lower) – MAX code = 23/55-54 Not codeable (i.e., a visible facial expression which doesn't fit into one of emotional expression categories; you're not sure what it is) – MAX code = 9 Other negative expressions – MAX code = 8 Other positive expressions, infant awake (i.e., surprise) – MAX code = 4 Neutral expression Infant is asleep/yawning/drowsy – MAX code = 1 Infant's face is obscured – MAX code = 0

Note. Gaze D, interest, touch, and sleepiness were removed from coding.

Maternal behaviors. Maternal behaviors and facial expressions were coded by observing gaze states, vocalizations, and touch. Smile was the primary maternal facial expression coded. Maternal gaze was coded in conjunction with infant gaze. Gaze included mom looking at infant, infant looking at mom, mom looking at infant/infant looking away, and mom looking away/ infant looking at mom. Vocalizations were coded as either positive or negative. Positive vocalizations were coded when mothers laughed and encouraged their infants, whereas negative vocalizations were coded if mothers became upset with their infants and changed their tone to a more negative one. However, due to a lack of prevalence of maternal negative vocalization, negative vocalization was not included in final analyses. Touch was coded when mothers reached out to touch their infants. Smile was coded as soon as mothers' lips began to curl before a smile.

Reliability. The several-coder technique was used in order to prevent bias. As a means of assessing inter-rater reliability, coders were compared on the scoring of 5 videos of mother-infant interaction. A 95% overall inter-rater reliability was established for all measured variables.

Data Analyses and Creation of Variables

Coding from the first minute of each phase was used to represent infant behavior within each phase. As in previous research (Bendersky & Lewis, 1998; Ukeje, Bendersky, & Lewis, 2001), this process ensured that the most intense behaviors were captured for both mothers and infants.

Infant behaviors. To determine how infant behavior changes across phases and whether there are sex differences in infant facial expressions and behaviors, 3 separate 2 (gender) x 3 (phase) ANOVAs with phases as repeated measures were conducted. Significant main effects were examined through the use of post hoc tests in which the critical *p* value was adjusted with the Bonferroni correction. Interactions were examined with the use of simple effects tests.

The three dependent variables were infant gaze at mother, infant vocalizations, and infant facial expressions. The variable of infant gaze at mother was constructed by combining the coded behaviors mutual gaze and mom looking away/infant looking at mom within phases 1 and 3. Since mothers were instructed to drop their heads in phase 2, mutual gaze did not contribute to infant gaze at mother in phase 2 and only mom looking away/infant looking at mom was used to construct the variable infant gaze at mother. The variable of infant vocalizations was created by calculating the difference between positive and negative vocalizations per phase. Positive difference scores indicated the presence of more positive vocalizations within a phase, whereas negative difference scores indicated the presence of more negative vocalizations within a phase. Finally the variable of infant facial expressions was created by calculating the difference between positive and negative facial expressions per phase. Positive facial expressions included the sum of the coded variables enjoyment and other positive expressions within each phase. Negative facial expressions included the sum of the variables anger, sadness, anger/sad, sad/anger, and other negative expressions within each phase. As described for infant vocalizations, positive difference scores indicated the presence of more positive facial expressions, whereas negative difference scores indicated the presence of more negative facial expressions.

Maternal behaviors. To determine how maternal behavior changes across phases and whether maternal behavior varies by the sex of infants, gaze, touch, vocalizations, and facial expressions were analyzed using 2 (gender of child) x 2 (phase) ANOVAs with phases as repeated measures. All mothers were told to drop their heads during the still-face phase, so the still-face phase was not included as a repeated measure. Dependent variables included in the analyses were gaze at infant, touch, positive vocalizations, and maternal smile. The variable gaze at infant was created by combining the coded behaviors mutual gaze and mom looking at infant/infant looking away within phases 1 and 3.

Results

Infant behaviors

Gaze at mother. Results of a 2 (gender) x 3 (phase) ANOVA for gaze at mother revealed that there was a main effect for phase [$F(2, 262) = 23.70$, $p < .001$, $\eta_p^2 = .15$] but not for gender [$F(1, 131) = .07$, $p = .79$, $\eta_p^2 = .00$]. The main effect for phase was due to infants looking at their mothers for the longest duration in phase 1 (*M* = 46.04 seconds; *SD* = 18.12), decreasing gaze at mothers in phase 2 (*M* = 32.95 seconds; *SD*= 20.04), and increasing gaze in phase 3 (*M* = 38.57 seconds; *SD* = 19.27) but not returning to phase 1 levels. All pairwise comparisons were significant (*p*s < .017), showing that the typical "still-face effect" was found for this variable. The interaction between phase and gender failed to reach significance [$F(2, 262) = .97$, $p = .38$, $\eta_p^2 = .01$].

Vocalizations. Results of a 2 (gender) x 3 (phase) ANOVA for vocalizations revealed that there was an interaction between phase and gender [Greenhouse-Geisser $F(1.86, 244.13) = 7.48$, $p < .01$, $\eta_p^2 = .05$]. Simple main effects analysis for the sex difference in infant vocalizations only reached significance for phase 3 ($p < .01$) and failed to reach significance for phase 1 ($p = .17$) and phase 2 ($p = .56$). The interaction resulted from girls (*M* = 4.05; *SD* = 10.10) vocalizing more positively than boys (*M* = -3.60; *SD* = 18.79) during phase 3. Simple main effects analysis also reached significance for boys ($p < .01$) but not for girls ($p = 1.0$). Pairwise comparisons revealed that boys' facial expressions between phases 1 and 2 and phases 1 and 3 were significantly different (*ps* < .01), but failed to reach significance when phases 2 and 3 were compared ($p = .03$), indicating that boys' negative vocalizations from phase 2 carried over into phase 3. Figure 2 shows the sex by phase interaction for infant vocalizations.

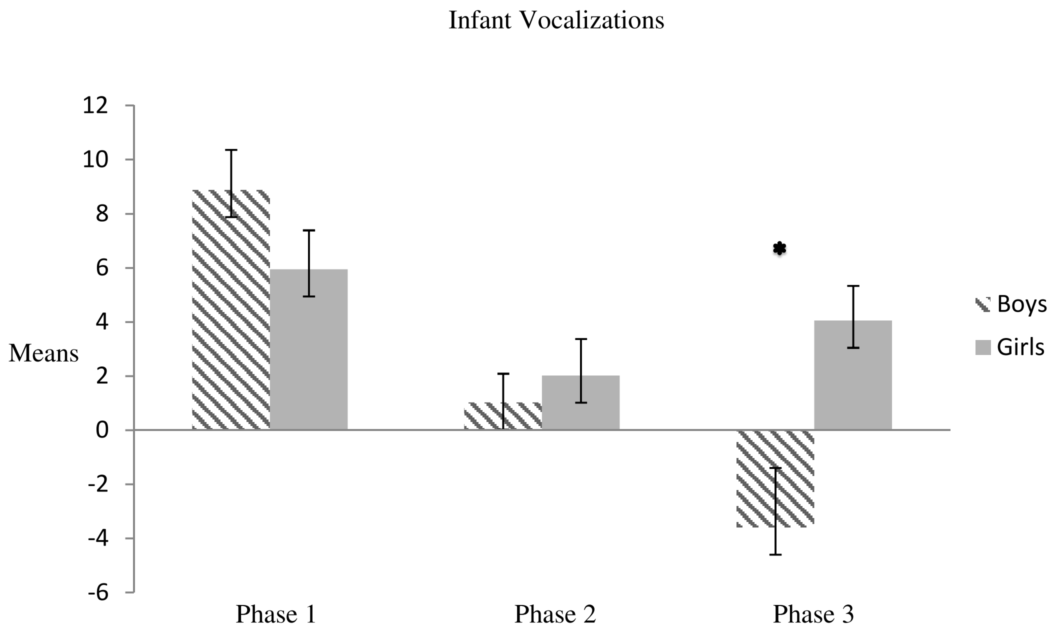

Figure 2. Mean difference scores for infant vocalizations. Difference scores were created by calculating the difference between infant positive and negative vocalizations per phase. (Asterisk indicates statistically significant difference at $p < .01$.)

For infant vocalizations there was also main effect for phase [Greenhouse Geisser $F(1.86, 244.13) = 15.38$, $p < .001$, $\eta_p^2 = .11$] and no main effect for gender [$F(1, 131) = 1.59$, $p = .21$, $\eta_p^2 = .01$]. However, the main effect for phase was not further interpreted in light of the significant interaction. Overall, results for infant vocalizations indicate that only boys demonstrated still-face and reunion effects, with boys decreasing in positive vocalization between phases 1 and 2, and maintaining a decrease into phase 3. Conversely, girls did not change in vocalizations across the entire still-face procedure. Table 2 displays means and standard deviations for all infant behaviors within each phase.

Table 2.

Means and SDs for Infant Facial Expressions and Behaviors During the Phases of the Still-Face Paradigm

Behavior or Facial Expression	Phase 1			Phase 2			Phase 3		
	Boys	Girls	Both	Boys	Girls	Both	Boys	Girls	Both
Gaze at Mother									
Mean	44.92	47.36	46.04	33.94	31.77	32.95	39.61	37.34	38.57
SD	17.84	18.51	18.12	21.13	18.77	20.04	19.94	18.54	19.27
Vocalizations (Positive-Negative)									
Mean	8.88	5.95	7.54	1.03	2.02	1.48	-3.60	4.05	-.09
SD	12.66	11.25	12.08	8.97	10.53	9.69	18.79	10.10	15.84
Facial Expressions (Positive-Negative)									
Mean	7.58	8.44	7.98	-2.76	-1.51	-2.19	-3.29	8.72	2.22
SD	18.75	21.10	19.79	8.01	8.27	8.12	21.76	17.24	20.64

Facial expressions. Results of a 2 (gender) x 3 (phase) ANOVA for facial expressions revealed that there was an interaction between phase and gender [$F(2, 262) = 6.29$, $p < .01$, $\eta_p^2 = .05$]. Simple main effects analysis for the sex difference in infant facial expressions only reached significance for phase 3 ($p < .01$) and failed to reach significance for phase 1 ($p = .80$) and phase 2 ($p = .38$). The interaction resulted from girls ($M = 8.72$; $SD = 17.24$) expressing more positive facial expressions than boys ($M = -3.29$; $SD = 21.76$) during phase 3. Simple main effects analysis also reached significance for boys ($p < .01$) and girls ($p < .01$). Pairwise comparisons revealed that boys' facial expressions between phases 1 and 2 and phases 1 and 3 were significantly different (*ps* < .01), but failed to reach significance when phases 2 and 3 were compared ($p = 1.00$), indicating that boys' negative facial expressions from phase 2 carried over into phase 3. Pairwise comparisons for girls' facial expressions revealed that girls' facial expressions were significantly different between phases 1 and 2, as well as phases 2 and 3 (*ps* < .01), but failed to reach significance when phases 1 and 3 were compared ($p = 1.0$), indicating that girls quickly recovered to phase 1 levels of facial expressions in phase 3. Figure 3 shows the sex by phase interaction for infant facial expressions.

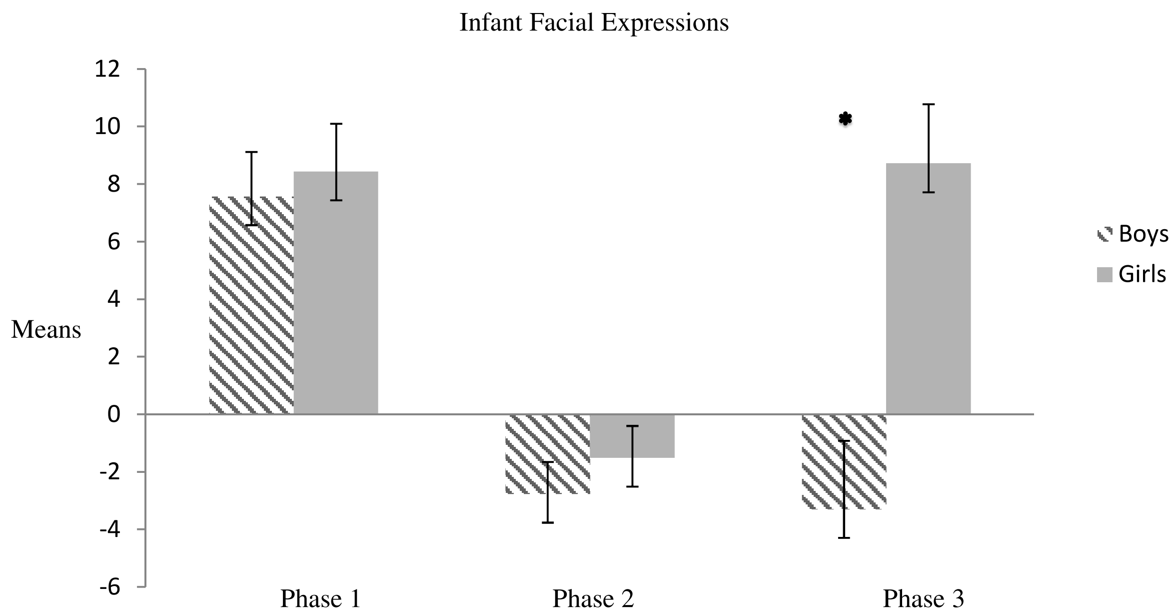

Figure 3. Mean difference scores for infant facial expressions. Difference scores were created by calculating the difference between infant positive and negative facial expressions per phase. (Asterisk indicates statistically significant difference at $p < .01$ and bars reflect SEMs.)

There was also main effect for phase [$F(2, 262) = 16.18$, $p < .001$, $\eta_p^2 = .11$] and a main effect for gender [$F(1, 131) = 5.08$, $p < .05$, $\eta_p^2 = .04$] for infant facial expressions but these main effects were not further interpreted due to the significant interaction. In summary, results for infant facial expressions reveal that both boys and girls demonstrated a still-face effect, as evidenced by a decrease in positive facial expressions between phases 1 and 2, but only boys maintained negative emotionality into phase 3.

Maternal behaviors

Gaze at infant. Results of a 2 (gender of child) x 2 (phase) ANOVA for gaze at infant revealed a main effect of phase [$F(1, 131) = 31.29$, $p < .001$, $\eta_p^2 = .19$] but no main effect of sex [$F(1, 131) = .06$, $p = .80$, $\eta_p^2 = .00$]. For the main effect of phase mean data revealed that maternal gaze decreased between phases 1 and 3 (phase 1: $M = 59.46$ seconds, $SD = 2.81$; phase

3: M = 56.24 seconds, SD = 5.88). There was no significant interaction between gender and phase for gaze at infant [F(1, 131) = .32, p = .57, η_p^2 = .00].

Touch. Results of a 2 (gender of child) x 2 (phase) ANOVA for touch revealed no main effects of phase [F(1, 131) = .10, p = .76, η_p^2 = .00] and no main effects of gender [F(1, 131) = .25, p = .62, η_p^2= .00]. There was also no significant interaction between gender and phase for touch [F(1, 131) = .39, p = .54, η_p^2 = .00].

Positive vocalizations. Results of a 2 (gender of child) x 2 (phase) ANOVA for positive vocalizations revealed a main effect of phase [F(1, 131) = 3.80, p = .05, η_p^2 = .03] and a main effect of gender [F(1, 131) = 6.60, p < .05, η_p^2= .05]. Looking at mean data for the main effect of phase revealed that maternal positive vocalizations decreased between phase 1 (M = 47.86 seconds, SD = 11.48) and phase 3(M = 45.90 seconds, SD = 10.10). Looking at mean data for the main effect of sex revealed that mothers positively vocalized significantly more to their girl infants (M = 49.05, SD = 9.76) than their boy infants (M = 45.05, SD = 11.33) across phases. The interaction between phase and gender failed to reach significance for positive vocalizations [F(1, 131) = .01, p = .93, η_p^2 = .00].

Smile. Results of a 2 (gender) x 2 (phase) ANOVA for maternal smile revealed a main effect of phase [F(1, 131) = 7.44, p < .01, η_p^2 = .05] and a main effect of gender [F(1, 131) = 5.11, p < .05, η_p^2= .04]. Looking at mean data for the main effect of phase revealed that mothers decreased smiling between phase 1 (M = 37.92 seconds, SD = 16.93) and phase 3 (M = 33.83 seconds, SD = 17.21). Looking at mean data for the main effect of gender revealed that across the two phases, mothers smiled significantly more to their girl infants (M = 39.01, SD = 16.90) than their boy infants (M = 33.22, SD = 16.79). The interaction between phase and gender failed to reach significance for maternal smile [F(1, 131) = 2.99, p = .09, η_p^2 = .02]. Figure 4 shows the main effects of sex and phase for the maternal behavior of smile, as well as the main effects of sex and phase for maternal vocalizations.

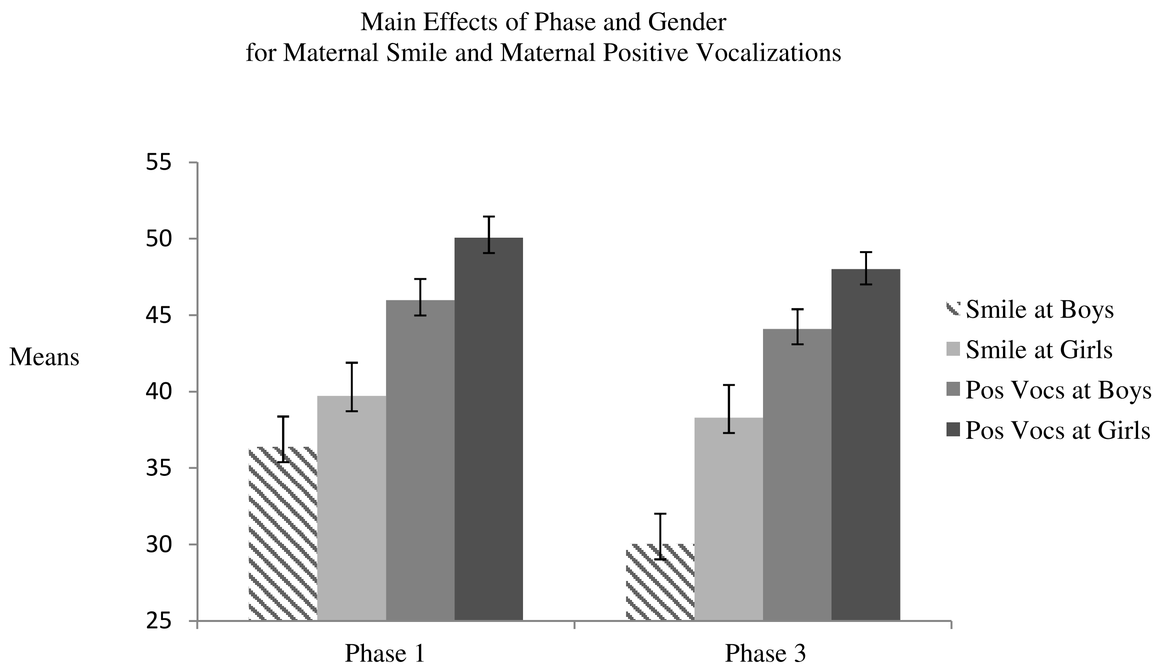

Figure 4. (Bars reflect SEMs)

To summarize, the results for maternal behaviors revealed that mothers changed their behavior between phases 1 and 3, as evidenced by decreases in gaze, positive vocalizations, and smiling. Mothers also consistently treated their girl infants more positively, as revealed through the main effects of positive vocalizations and smiling. Table 3 displays means and standard deviations for all maternal behaviors within phases 1 and 3.

Table 3.

Means and SDs for Maternal Facial Expressions and Behaviors During the Phases of the Still-Face Paradigm

Behavior or Facial Expression	Phase 1			Phase 3		
	Boys	Girls	Both	Boys	Girls	Both
Gaze at Infant						
Mean	59.54	59.36	59.46	56.03	56.49	56.24
SD	1.41	3.86	2.81	.82	.56	5.88
Smile						
Mean	36.40	39.72	37.92	30.04	38.30	33.83
SD	16.81	17.03	16.93	16.77	16.77	17.21
Touch						
Mean	19.75	20.26	19.99	19.18	21.95	20.45
SD	21.54	23.12	22.19	20.02	21.49	20.68
Positive Vocalizations						
Mean	45.99	50.08	47.86	44.11	48.02	45.90
SD	11.75	10.84	11.48	10.92	8.67	10.10

Discussion

The data partially supported the hypothesis that boys would react with more negative emotions to the still-face and reunion phase. The sex by phase interaction for infant facial expressions and infant vocalizations revealed that girls expressed more positive facial expressions and more positive vocalizations than boys. However, this sex difference was only present within phase 3. The current findings on sex differences in infants are similar to findings on sex differences in 2 ½ month old infants reported by Cossette et al. (1996), in that no significant sex differences between boy and girl infants in phases 1 or 2 were found.

The hypothesis that mothers would use different behaviors when interacting with their girl versus boy infants was also supported. Mothers positively vocalized and smiled more at their girls versus boys across all phases. A lack of a sex by phase interaction revealed that mothers treated girls better than boys independent of context. This is consistent with the findings of Lewis (1972), Goldberg and Lewis (1969), and Clearfield and Nelson (2006), as mothers are positively interacting more with their girl versus boy infants.

It was expected that mothers would increase in negativity between phases 1 and 3. This hypothesis was supported. Mothers decreased in gaze at infants, positive vocalizations, as well as smiling. This supports Mayes, Carter, Egger, and Pajer's (1991) argument about changes in maternal behavior after the still-face phase. Mothers did not return to phase 1 levels of interaction.

The final hypothesis concerning boys' but not girls' continuation of negativity between phases 2 and 3 was supported. Boys' negative facial expressions and negative vocalizations continued from phase 2 into phase 3, whereas girls demonstrated a significant increase in positive facial expressions between phases 2 and 3. Furthermore, girls did not change in vocalizations across the entire still-face procedure, indicating that they were not as negatively affected by the procedure as boys.

The findings from this study suggest that 2 ½ month old boys react with more negativity than girls within the still-face paradigm, but solely within the reunion phase. If mothers did not differ in their behavior to boy versus girl infants and maternal behavior was constant between phases 1 and 3, it would be likely that this sex difference in the reunion phase was primarily due to biological differences between boys and girls. However, once maternal behavior is included it becomes evident that mothers are at least partially responsible for the sex differences observed in infant behavior. Mothers are consistently treating their girl infants with more positivity than their boy infants. Mothers are also decreasing in positive vocalizations and smiling across phases. Given these findings, it is likely that decreased maternal positivity in phase 3 for boys is leading to the continuation of negative facial expressions and negative vocalizations for boys, but not girls.

Interestingly, differential maternal behavior does not translate into sex differences in infants within phase 1 or the still-face phase. Boys and girls may not be differing in behavior in phase 1 even though mothers are treating them differently because they have not yet experienced a stressor (still-face phase) and maternal behavior is not yet as negative as phase 3 maternal behavior. Furthermore, if underlying genetic differences were the only driving force of socio-emotional sex differences, it would be likely that at least some sex differences would be evident in the still-face phase, when mothers all acted similarly independent of infant sex. Yet, this was not the case.

A question which arises in light of the results is why would mothers treat their girl versus boy infants differently? One answer to this question seems to lie in stereotypes associated with girls versus boys. As early as 24 hours after birth girls are perceived by parents as being more delicate, fragile, and attractive, even when they do not differ in weight from boys (Rubin, Provenzano, & Luria, 1974). These perceptions affect parental behavior, as evidenced by studies which reveal that mothers differ in behavior towards an unfamiliar infant when the infant is dressed as a boy versus a girl (Will, Self, & Datan, 1976). Mothers seem to behave more according to their expectations, rather than any behaviors evident in boys versus girls (Will, Self, & Datan, 1976). In the current study mothers' perception of girl infants as being more fragile than boys could have contributed to more positive maternal behavior towards girls.

However, it could also be the case that there are slight differences in boy versus girl infants which affect maternal behavior. In fact, boys are exposed to higher levels of androgens before birth (Hines & Kaufman, 1994). This has a masculinizing effect on their nervous system (Hines & Kaufman, 1994). Mothers could pick up on these subtle sex differences and subsequently alter their own behavior. Furthermore, these biologically-linked sex differences may not be detected early in development, but become more pronounced as infants mature. In the current study, differences between boys and girls may have not been detected within phases 1 and 2 because sex-linked biological differences in infancy may be very subtle. As infants mature and further hormonal changes occur in both boys and girls during puberty, biological sex differences can become more obvious.

Overall, the current study demonstrated that environmental factors clearly play a role in observed sex differences in infants, and failing to adequately incorporate environmental factors into analyses of infant sex differences can lead to incomplete conclusions about sex-linked differences in infant behavior. Specifically, maternal behavior should always be analyzed jointly with infant behavior. It is likely that both genetic and environmental factors play a role in the development of later sex differences in externalization and internalization of emotions, but previous studies have failed to explore this interaction sufficiently by failing to analyze maternal behavior in depth. This is especially true with analyses of sex differences within the still-face paradigm. Mothers differ in their behavior within the still-face paradigm by the sex of the child and they differ across phases of the still-face paradigm. Further studies need to be conducted to elucidate the contributions of biological factors and environmental factors in the development of sex differences in infants' socio-emotional behavior.

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